NOTICE

U.S. Department of Transportation
Federal Aviation Administration

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SUBJ: GUIDELINES FOR THE APPROVAL OF FIELD-LOADABLE SOFTWARE

1. PURPOSE. This notice provides guidelines to Federal Aviation Administration (FAA) Aircraft Certification Office (ACO) personnel and authorized Designated Engineering Representatives (DER) for approving field-loadable software (FLS). These guidelines are applicable to software data approvals related to type certificate (TC) approvals, amended type certificate (ATC) approvals, supplemental type certificate (STC) approvals, or Technical Standard Order (TSO) authorizations. Additional policy is being prepared to address the Parts Manufacturer Approval (PMA) process for software. This notice is for guidance purposes only and is supplemental to document RTCA DO-178B, "Software Considerations in Airborne Systems and Equipment Certification," dated December 1, 1992.

2. DISTRIBUTION. This notice is distributed to the branch level in Washington Headquarters Aircraft Certification Service, branch level in all Aircraft Certification Directorates, all National Resource Specialists (NRS), all Aircraft Certification Offices (ACO), all Manufacturing Inspection Offices (MIO), all Manufacturing Inspection District and Satellite Offices (MIDO and MISO), and all Flight Standards District Offices (FSDO). Additional limited distribution should be made to the Air Carrier District Offices, the Aeronautical Quality Assurance Field Offices, and the FAA Academy.

3. RELATED PUBLICATIONS.

a. Title 14 Code of Federal Regulations (14 CFR) part 21, "Certification Procedures for Products and Parts."

b. Advisory Circular 21-33, "Quality Assurance of Software Used in Aircraft or Related Products."

c. Advisory Circular 20-115B, "RTCA, Inc. Document RTCA/DO-178B."

d. RTCA, Incorporated, document DO-178B, "Software Considerations in Airborne Systems and Equipment Certification," dated December 1, 1992.

4. DEFINITIONS.

a. Field-loadable software is software that can be loaded without removal of the equipment from the installation. Field-loadable software can refer to either executable code or data. (Refer to DO-178B, paragraph 2.5.)

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b. User-modifiable software, as the term is used in DO-178B, is software intended for modification by the aircraft operator without review by the certification authority, the airframe manufacturer, or the equipment vendor. Modifications by the user may include modifications to data, modifications to executable code, or both. (Refer to DO-178B, paragraph 2.4.)

c. Option-selectable software is software that contains approved and validated components and combinations of components that may be activated by the user, either through selection by the flight crew or activation by ground personnel. (Refer to DO-178B, paragraph 2.4.)

5. BACKGROUND. Through technological advances, the field loading of software has become a common process. This process reduces aircraft down-time for maintenance and increases efficiency of maintaining airborne equipment. DO-178B, paragraph 2.5, provides some system design considerations for FLS; however, the existing guidance for approval of FLS through the TC, ATC, STC, or TSO processes is limited. This notice provides additional guidelines for the ACO engineer or authorized DER approving FLS using the TC, ATC, STC, or TSO process. This notice should be applied in conjunction with DO-178B, paragraph 2.5.

6. THE USE OF EARLIER VERSIONS OF DO-178. Versions of DO-178 earlier than Revision B do not provide any guidance regarding FLS, and should not be used as a means of compliance for FLS approvals. For software developed to previous guidelines, at least the field-loadable component and the protective schemes of the component, should be demonstrated to meet the guidelines contained in DO-178B or an alternate means of compliance, as agreed to between the applicant and the cognizant ACO.

7. APPROVAL OF FIELD-LOADABLE SOFTWARE (FLS). The following procedures should be implemented as part of the TC, ATC, STC, or TSO process for the approval of FLS:

a. It should be confirmed that the software meets the objectives of DO-178B or another acceptable means of compliance, as agreed to between the applicant and the cognizant ACO.

b. It should be confirmed that the considerations outlined in DO-178B, paragraph 2.5, have been addressed.

c. It should be confirmed that the software and hardware configuration were verified/tested together during the verification process (i.e., the software must be installed on the target computer in which the approval was granted).

d. There should be a Configuration Management (CM) process in place to assure that the installation configuration (i.e., software part number, the hardware part number, the aircraft model, and the aircraft serial number combination, as applicable) is the same configuration that was approved during the TC, ATC, STC, or TSO process.

e. If redundant parts on the aircraft are field-loadable, the applicant should define the following: (1) the requirements for intermixing different software loads on the parts, (2) requirements for partially successful and partially unsuccessful loads, and (3) the aircraft dispatchability effects of successful and unsuccessful loads on redundant parts.

f. There should be a process in place to assure that the software loaded is the software approved and that the software has not been corrupted (e.g., Cyclic Redundancy Check (CRC)). This process should include checks during product manufacturing, before installation onto the product, and after installation on the product.

NOTE 1: Per 14 CFR §21.1(b), a "product" is an aircraft, an aircraft engine, or an aircraft propeller.

NOTE 2: Different CRC algorithms give different assurances that the data transferred is correct. The applicant and approving authority should assure that the algorithm used is sufficient for the integrity required for the software level of the data being loaded.

g. If there is no process in place to assure that paragraph 7f above has been addressed, the airborne equipment to be field loaded should demonstrate compatibility with the onboard loading system during the verification process.

h. If there is no process in place to assure that paragraph 7f above has been addressed, the onboard loading system should be approved considering the following items:

(1) The applicant should demonstrate that the onboard loading system is in compliance with the guidelines of DO-178B, paragraph 2.5 or alternate means of compliance as described in Section 6 of this notice.

(2) The applicant should provide documentation defining the operation of the onboard loading system and the recommended means for maintaining configuration control of equipment by the operator. This documentation should include guidelines for the configuration control processes which meet the guidelines outlined in this notice.

(3) The applicant's onboard loading system and procedures should be approved by the cognizant ACO. Depending on the implementation, this approval may include the data loader, as well as the procedures.

NOTE: Many approaches to data loading do not require evaluation of the data loader because integrity checks are built into the data and the data transfer process (see paragraph 7f of this notice).)

(4) If the applicant proposes more than one medium for onboard loading (e.g. diskette, mass storage, etc.), loading from all mediums should comply with the guidelines in this notice.

i. The applicant should demonstrate the ability to verify the airborne equipment software part number with onboard equipment, carry-on equipment, or other appropriate means.

j. Changes to FLS of software levels A or B, or equivalent software levels (e.g., DO-178A software level 1), should be reviewed and approved by the cognizant ACO.

k. Changes to FLS of software levels C, D, or E, or equivalent, should be coordinated with the cognizant ACO to assess any effects on the aircraft and to determine whether the changes are minor or major.

l. FLS which is also user-modifiable and has been approved by the cognizant ACO as user-modifiable does not require further determinations of compliance for dissemination and installation (reference DO-178B, paragraph 2.4).

8. <u>INSTALLATION CONSIDERATIONS.</u> The approved FLS may be installed on the aircraft via Service Bulletin, Engineering Change Request, or other FAA approved means. The approved means of installation varies, depending upon the method for granting approval. Whether the FLS approval is through TC, ATC, STC, TSO, or some other approval process, the document used to install the FLS should be approved by the cognizant ACO and should specify the following elements:

a. The aircraft and hardware applicability.

b. Verification procedures to assure that the software was correctly loaded into an approved and compatible target computer.

c. Any post load verification and/or test procedures required to show compliance to the guidelines specified in this notice.

d. Actions to be taken in the event of an unsuccessful load.

e. Reference to an approved loading procedure.

f. Maintenance record entry procedures required to maintain configuration control.

g. Reference to Aircraft Flight Manual, Aircraft Flight Manual Supplement, or Operator's Manual, as appropriate.

9. MAINTENANCE AND PART MARKING CONSIDERATIONS. Maintenance and part marking for FLS should be performed in accordance with the appropriate part of 14 CFR. Additional maintenance and part marking considerations that apply specifically to FLS using TC, ATC, STC, or TSO, process are discussed below:

a. The applicant's Aircraft Maintenance Manual (AMM) or Instructions for Continued Airworthiness (IFCA) should include the procedures to be followed when conducting maintenance on airborne equipment using field-loadable software.

b. The applicant's AMM or IFCA should include a procedure that requires maintenance personnel to verify the software part number configuration before and after maintenance is performed on the airborne equipment.

> NOTE: If the software loading cannot be verified (e.g., procedures do not render proper results, checksum fails, part number does not match approved part number, etc.), the system should not be considered functional and the aircraft should not be dispatched. In some cases Minimum Equipment List (MEL) procedures may allow dispatch with some inoperative equipment. In the case of equipment whose software part number cannot be verified, the MEL should specify whether the affected equipment may be disabled and the aircraft subsequently returned to service. Other means to clear the aircraft for dispatch depend on the MEL limitations.

c. It is the responsibility of maintenance personnel to ensure the identified part is recorded in the necessary maintenance logs.

d. For airborne equipment having separate part numbers for hardware and software, the software part numbers need not be displayed on the outside of the unit, as long as it can be verified through some kind of electronic query. It is the maintenance personnel's responsibility to ensure that the software part identification has been logged. When new software is loaded into the unit, the same requirement applies and the approved software part number should be verified before the unit is returned to service.

e. For airborne equipment having only one part number, which represents a specific configuration of software and hardware, the unit identification on the nameplate should be changed when the new software is loaded. When new software is loaded, the software part number stored in the target computer after data loading should be verified electronically. It should be verified that the electronic software part number and the unit part number displayed on the nameplate are an approved configuration prior to returning the unit to service.

f. Changes to software part number, version, and/or operational characteristics should be reflected in the Operator's Manual, Aircraft Flight Manual, Aircraft Flight Manual Supplement, and/or any other appropriate document.

James C. Jones
Manager, Aircraft Engineering Division
Aircraft Certification Service